Filling the Gaps

Climate and Weather Information for Small- and Medium-size Water Utilities

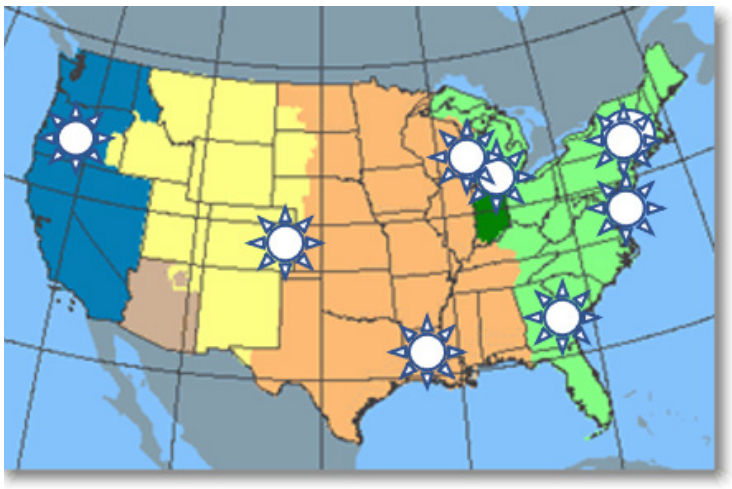
Project Summary

July 2019–October 2020 Workshop Series

Project Overview and Method

This workshop series was designed by the National Oceanic and Atmospheric Administration (NOAA) and the Water Research Foundation (WRF) to improve the delivery of climate and weather information resources for small- to medium-size water systems with the goal of building their resilience to climate change. Seven regional workshops were held. An additional stand-alone webinar on water equity was held in the Great Lakes Region, planned and held jointly by the US Water Alliance and NOAA.

Each workshop was organized by NOAA and its national and regional partners and were tailored to address issues identified by and for each region. Regional leads were asked to reach out to the water sector – community drinking water and wastewater utilities, stormwater managers, urban planners, public works departments, etc. – to design agendas according to regional interests and preferences. As a result, every workshop was different, varying in length, number of sessions, agendas, and in one case, one-on-one interviews in place of a workshop. Collectively, approximately 900 people participated in the workshop series.



Lessons Learned in the Water Sector

Managing Stormwater and Flooding

Planners almost universally expressed the need for updated, local scale information, including maps, statistics, forecasts, and projections - including precipitation statistics, floodplain maps, sea-level rise, high tide storm surge, and high river water levels. At a minimum, updated information is needed that: uses the most current observational data, including hourly and sub-hourly data; updates intensity-duration-frequency statistics including NOAA Atlas 14; and, ideally, provides methods to estimate future changes for long term planning. Updated precipitation and flood statistics are particularly needed for the 50- and 100-year events that appear to be happening more often in some communities.

FOR MORE INFORMATION, VISIT THE ***WORKSHOP SERIES WEBSITES*** *+ DOWNLOAD THE WORKSHOP FACTSHEETS*

NOAA WORKSHOP SERIES
- *cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/Water-Resources/Water-Utility-Study*

MARISA/CCRUN WORKSHOP
- *Download Factsheet*
- *rand.org/events/2020/03/05/webinars.html*

GLISA WORKSHOP
- *Download Factsheet*
- *glisa.umich.edu/stormwater-webinar*

SERCC WEBSITE
- *Download Factsheet*
- *sercc.com*

PNW WORKSHOP
- *Download Factsheet*
- *waterrf.org/research/projects/using-climate-information-water-utility-planning*

SCIPP WEBSITE
- *Download Factsheet*
- *southernclimate.org*

NRCC WORKSHOP
- *Download Factsheet*
- *nrcc.cornell.edu/workshops/mar_2020_utility/utility.html*

WWA WEBSITE
- *Download Factsheet*
- *wwa.colorado.edu*

EQUITY WORKSHOP
- *Download Factsheet*

APPENDICES
- *cpo.noaa.gov/Portals/0/Docs/Water-Resources/Project-Appendices.pdf*

State and local codes often do not reflect the most recent precipitation data that is available, resulting in the use of outdated information by engineers and planners. Engineers and planners are less likely to use updated information or future projections in system design until they are incorporated into state and local code and standards. Furthermore, updating stormwater policy to address extreme precipitation is encumbered by the wide range of approaches that are being discussed by the research community. Widespread adoption will rest on development of consistent methods and best practices for incorporating downscaling into hydrologic modeling and system design.

Most communities are not relying on climate downscaling to make decisions, but are taking many practical steps to evaluate system performance and adopt policies to limit vulnerability, such as using regional approaches to integrated planning; consolidating departments for stormwater management oversight; creating dynamic models to evaluate system performance; upscaling design storms; and conducting sensitivity analyses and vulnerability assessments to target investments for infrastructure upgrades.

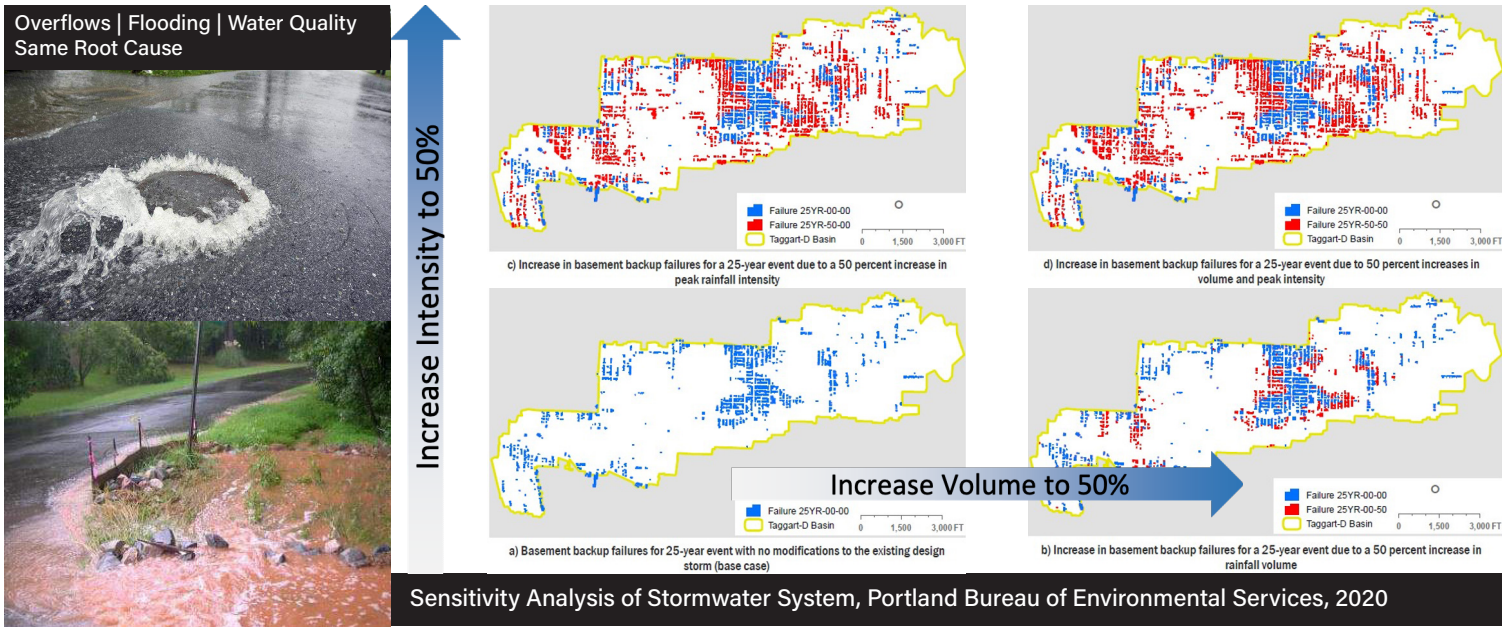
The differences in scale and resolution between climate model outputs and hydrological model inputs makes it extremely difficult for any but the most sophisticated modelers to merge the two. Without reliable and widely adopted methods, it is unlikely that there will be widespread use of climate models in local water utility management beyond some scenario planning, vulnerability assessments, and qualitative sensitivity analyses.

Assumptions about design storms are significant and affect the performance of stormwater and flood control systems. Anomalies were noted in three workshops where rainfall was notably different across the city or geographic region (i.e., Mountain West, Pacific Northwest, and Southeastern Coast). Some were attributed to micro-climates.

Many utilities have developed hydrologic and hydraulic (H&H) models, but extreme conditions may invalidate their calibration to historical precipitation. Furthermore, H&H models are typically simplified (e.g. conduit skeletonization, subcatchment aggregation) that limits their use in evaluating performance of stormwater systems. Despite the difficulties, larger cities are working with researchers to experiment with methods for improving H&H modeling including better representation of the constructed hydraulic system, creating dynamic models, and even incorporating climate projections.

Dynamic coupling of H&H models has helped some communities evaluate risk, visualize impacts, and align investments with hazard mitigation. Dynamic models include, for example, coastal hydrodynamics, tidal fluctuations, surges and sea level rise, inflow through storm sewers, overland rainfall-runoff, groundwater flow, etc.

More research is needed on understanding and preparing for cloudbursts (short duration heavy rainfall events). Stormwater systems are typically designed based on 12-hour or 24-hour rain values (occurring every 1-2 year) and street drainage is typically based on 24-hour rains (occurring every 10-years). However, rain is frequently occurring in intense, short duration (minutes to hours) bursts that cause stormwater, storm sewers, sanitary sewers, and streets to flood.



Sensitivity Analysis of Stormwater System, Portland Bureau of Environmental Services, 2020

Water Supply

Soil moisture deficits are increasingly affecting runoff, especially in the intermountain west. Dry soil conditions are increasingly a dominant factor even in areas with adequate snowpack, and local water managers are starting to understand these connections. A simplified water budget analysis illustrates that streamflow may decrease by as much as 25% with a 10% increase in evapotranspiration. These deficits are creating more pressure on communities to conduct vulnerability assessments, improve community education, and develop drought contingency plans.

Understanding changes in snowpack is becoming more critical for water supply managers. More SNOTEL monitoring sites and methods to track mid- and high-elevation snow such as the use of airborne snow observations will increase planners' ability to manage water supply as well as potential flood conditions.

Some participants felt capable of managing water supply and demand but needed better local scale near-term forecasts for advance preparations, e.g., 2-3 week precipitation forecasts, alert of rapid switching between wet and dry periods and flash drought, and likelihood of extended number of El Niño-Southern Oscillation (ENSO) years.

Anacortes, WA Water Treatment Plant
Watertight Construction

Drought conditions have left the water level unusually low at Swan Lake, pictured here in late August, and other Maine waterways | Bill Baxter | BDN

Equity

Lower income areas are often located in areas with old and aged infrastructure and are subject to increased incidences of sewer backups and basement flooding as well higher vulnerability to catastrophic flooding. Providing equitable levels of service is challenging due to issues of affordability and lack of funds to replace aging infrastructure.

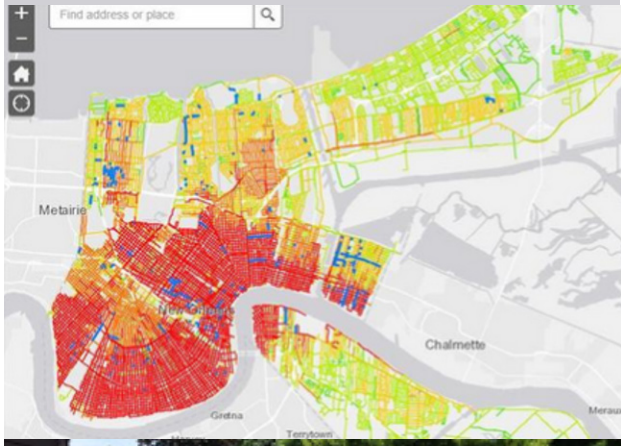
Adopting a community-based approach, while evaluating climate adaptation options, leads to more successful projects that benefit all residents and achieves triple bottom line benefits for social, economic, and environmental resilience

Engaging trusted neighborhood residents as champions and ambassadors fosters common understanding between city and utility staff and community members, and helps connect communities to resources for project funding and affordability.

To redress inequity, communities could: map the overlay of physical science, infrastructure condition, and social data to understand vulnerability in order to focus work where it is most needed; and adopt innovative and dedicated funding.

Participants identified a need for practical equity and inclusion training in order to break down institutional and systemic barriers to equitable resilience planning. Participants asked for peer-to-peer exchanges and conversations about equity to learn from counterparts in other cities about what's working and what's not, and how to build a shared understanding and communication with populations they serve.

Mapping Vulnerability in New Orleans



Milwaukee Metropolitan Sewerage District
Fox Rain Garden

Capacity Building and Financing

Small- and medium-sized water utility staff have limited expertise and technical capacity to use climate change information; and limited time and resources to be trained on available tools or to find and use existing information that could inform plans. Providing more context on the meaning of NOAA's climate and weather information would help small- and medium-sized water utilities to understand its meaning, take action, and communicate to their communities.

Barriers to using available tools and information include:

- Time to find the appropriate tool especially given how many there are;
- Discerning the relevance of the tool to the application, the scale, and the particular location;
- Understanding accuracy and reliability when the results look like a 'black box';
- Lack of confidence in non-standardized tools especially whether they would be approved by regulators; and
- Lack of context and perspective on how to use information.

Utilities repeatedly emphasized the value of learning from their peers. Seeing how peers use climate information and how they put adaptation into practice helps to integrate solutions with their areas of expertise, and lends credibility and confidence in using new information, tools, and methods. Many participants noted their engagement with existing regional water practitioner networks.

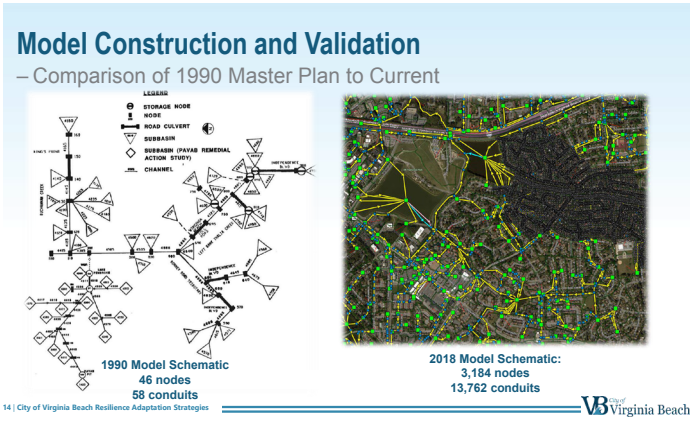
Some utilities are impeded by organizational culture that is resistant to new methods or community culture ambivalent about climate change. In addition, loss of institutional and watershed knowledge due to retirements is both a positive and a negative. In some cases, essential historical knowledge is lost; in other cases, retirements enable younger staff to embrace new methods and strategies.

Scientists can improve the useability of information and help organizations get buy-in to adopt new information and practices with appropriate:

- *Geographic Scale:* The right scale for the user.
- *Skill of info:* A track record of consistently and accurately projecting climate conditions.
- *Understandability:* Information is tailored to users' technical capacity.
- *Coproduction:* Actively engage users in development of new information products.
- *Organizational Factors:* Information is provided by trusted sources, a community of practice tests new methods, and the organization has resources to allow staff training.

Financing challenges are exacerbated due to changing conditions experienced by utilities, such as drought-induced water conservation that reduces revenue, decline in populations served leaving underused infrastructure, deteriorating conditions of infrastructure, and increased costs of maintenance and repairs. Affordability is especially an issue in small and low income communities, and in cities with aging infrastructure.

Overall, participants relayed that there is a perception that proactive adaptation is costly. However, utilities have estimated that investing in adaptation avoids costly future damages. Acceptance of climate change adaptation is increased when it is integrated into ongoing planning and operations, including during the scoping phases of new or upgraded systems.

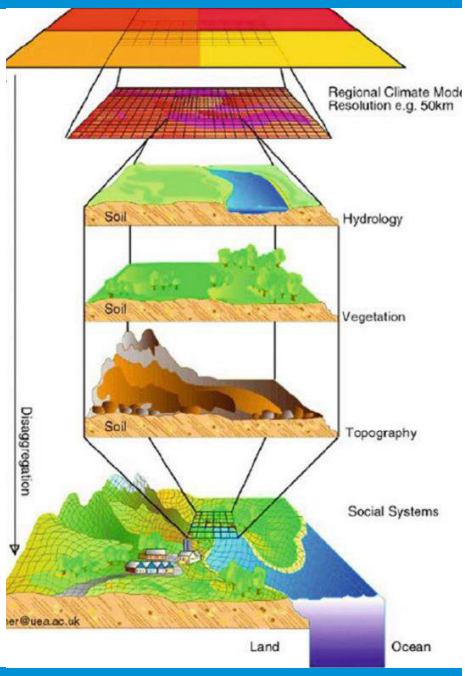


For long term planning, planners are trying to figure out how to integrate capital planning with climate models to ensure that projects are built to be future proof and are able to cope with multiple complex overlapping hazards. Integrating questions on climate risk into capital planning checklists can be one step to integration.

Information and Research Needs

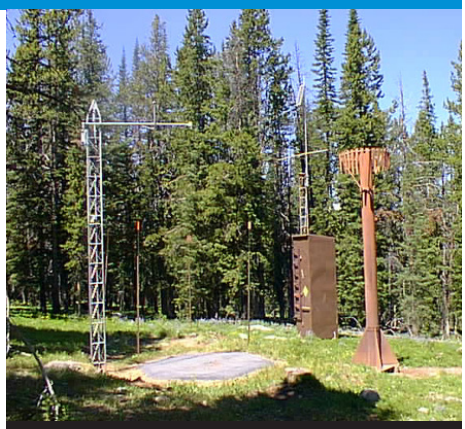
Stormwater and Flooding

- Collect more local scale hourly and sub-hourly data with rain gages
- Update local scale precipitation statistics
- Update precipitation and flood return periods, particularly 50- and 100-year events
- Update NOAA Atlas 14 or provide alternative intensity-duration-frequency (IDF) statistics
- Provide IDF curves incorporating climate change for long-term planning
- Improve understanding of precipitation variability, runoff, and flooding
- Quantify the range of uncertainty in forecasts and management and design decisions
- Provide local lightning and wind forecasts for maintenance crews
- Improve understanding of short-duration heavy rainfall events
- Improve prediction of local-scale heavy rainfall
- Provide probabilities of confluence of low probability, high impact events
- Conduct research and provide data on local-scale micro-climates
- Conduct research on past and future heavy rainfall



Water Supply

- Improve understanding of potential evapotranspiration (PET)
- Conduct more soil moisture tracking
- Improve information on soil moisture conditions and effects on runoff, water supply, and flooding
- Enhance mid- and high-elevation snow information
- Build better spatial resolution of Snow Water Equivalent (SWE)
- Deploy more SNOTEL monitoring sites
- Conduct more mid- and high-elevations observations from LIDAR, i.e., airborne snow observations
- Improve local-scale precipitation forecasts, including 2-3 week precipitation forecasts
- Explain ENSO projections, especially if expecting more than 2 consecutive years



Beartooth Lake SNOTEL site, Wyoming
Credit: NRCS

Milwaukee Metropolitan Sewerage District, Lincoln Creek, Milwaukee, Renaturalizing a Stream: Before and After

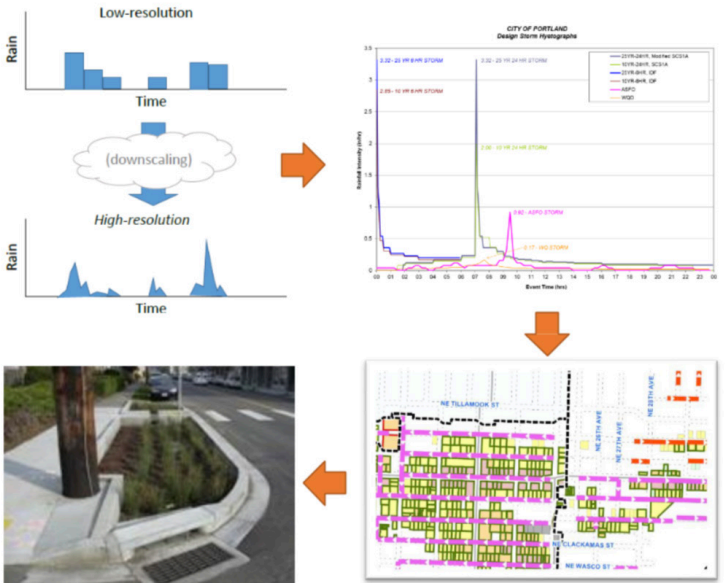
- Develop warnings of rapid shift between wet/dry conditions and flash droughts
- Provide better estimates of available groundwater data
- Provide guidance on water supply risk triggers; and storm readiness triggers
- Develop guidance on trigger levels for groundwater and surface water supplies

Equity

- Provide trainings to break down institutional and systemic barriers to equitable resilience planning
- Build understanding of what equity means for this sector, and how to do more equitable planning.

Capacity Building and Financing

- Disseminate information on how to finance adaptation and how to estimate cost-benefit and return on investment for stormwater and other water sector adaptation strategies
- Demonstrate how to integrate climate assessments into capital planning
- Provide methods for making decisions under uncertainty
- Provide technical assistance to overcome barriers to information use
- Provide opportunities for peer-to-peer learning and provide more case studies
- Leverage existing professional networks
- Leverage the relationships between small and large regional utilities to disseminate information, as small utilities often rely on larger utilities for information and guidance
- Build Communities of Practice to provide guidance and make information transferable
- Expand options for online workshops and trainings to meet demand and expand geographical reach



Testing downscaled models for system design, Portland, Oregon
Credit: Nishant Parulekar

Feedback on NOAA's Tools and Information

NOAA's websites contain a plethora of information and tools, much of which is useful for the water sector. However, NOAA's websites are overwhelming. Participants universally requested simplified access to information including simplified ways to find appropriate, usable, locally relevant information.

This sector needs scientific information that is more accessible and digestible and that conveys information to aid interpretation that is meaningful for the water sector.

Provide guidance and tools to help water professionals assimilate and communicate information - including guidance on communicating risk, uncertainty, and tradeoffs - to decision makers and the public would help get buy-in for adaptation.

There is a universal demand for updating NOAA Atlas 14. This need is driving some localities to invest in figuring out how to re-calculate IDF curves themselves, including how to create climate-adjusted IDF curves.

Lightning | Credit: NASA

Next Steps

Develop new tools and communication products, e.g.,

- Develop Case studies about water utilities' exceptional practices
- Update the NOAA Water Resources Dashboard and the Climate Resilience Toolkit
- Work with NOAA program offices to provide feedback on use of their information and resources
- Partner with water associations and regional organizations to promote peer learning and other activities to advance meeting user needs
- Produce peer-reviewed and trade journal articles about outcomes of this project, and present findings at conferences and meetings

For more information
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Funding provided by the NOAA Water Initiative and the Water Research Foundation